4. JADS EW T&E Test Methodology

The EW test methodology incorporates the collective application of the various segments of the EW multiphased approach. As an integrated test approach, the SPJ Test (Phase I and II) and ADEWS will address pertinent JADS level issues. The aggregate analysis of each component's contribution will provide insight into the utility of ADS for EW T&E.

4.1 Structured Breakdown of Issues

The JADS JT&E test issues are the present utility of ADS for T&E; the critical constraints, concerns, and methodologies associated with ADS; and the future ADS requirements to support a more complete T&E capability. These issues are common across all JADS JT&E test activities (i.e., SIT and ETE), and the EW test will address the associated objectives, subobjectives, and measures by applying them to the EW test activities. The results will be analyzed and used to support conclusions both about ADS in EW T&E as well as the broad application of ADS to T&E in general. The sections to follow list and describe the objectives or issues for each EW test that will ultimately have an impact on the JADS-level issues. These sections are followed by Table 4-1, which shows the entire JADS-level issue breakdown and consolidates the relevant EW test objectives which support each measure.

4.1.1 ADEWS Issues

Development of ADEWS will provide several areas of direct interest to the EW test. While there is not yet a published list of objectives, the areas to which ADEWS is expected to contribute have been identified in Table 4-1. Any relevant data will be collected by the Army during their conduct of the preliminary tests and final proof-of-principle.

A second objective of JADS involvement in ADEWS is the methodology for the VV&A process in a distributed environment. Specific ADEWS subsystem and component level data gathered in Army laboratory testing will be used to establish the validity of data from subsequent field demonstrations using the full set of ADS features implemented by ADEWS. A typical approach envisioned is that quantitative methods will be used to establish validity, i.e., test data will be compared with non-ADS test data gathered prior to the proof-of-principle demonstration. It is expected that necessary validity data will be collected by the Army as part of their systems development and integration test process for the ADEWS.

4.1.2 Phase I Self-Protection Jammer Test Objectives

The objectives unique to the SPJ test are as follows:

- **SPJ Obj 1: Measure SUT performance data in each environment**
  - **Subobj 1-1: Open Air Range (Baseline)**
  - **Subobj 1-2: ADS Digital System Model**
  - **Subobj 1-3: ADS Hardware-in-the-Loop**
  - **Subobj 1-4: ADS Installed System Test Facility**

The purpose of Objective 1 is to obtain the basic data needed to perform an analysis of the performance of the ADS system. Performance in this sense does not relate to specific network statistics, but rather the behavior of the SUT. It is concerned with data that will be used to address the issue of technical ADS feasibility through comparisons and correlation between the test environments. Subobjective 1-1 will establish a performance baseline for the SUT which will be correlated with performance data collected in subobjective 1-2, 1-3 and 1-4. The intent of each subobjective is to capture performance parameters specific to SPJ test activities.

- **SPJ Obj 2: Establish repeatability of OAR and ADS test results**
  - **Subobj 2-1: Open Air Range**
  - **Subobj 2-2: Digital System Model**
  - **Subobj 2-3: Hardware-in-the-Loop**
  - **Subobj 2-4: Installed System Test Facility**

In order to establish the validity of the test results, the measurements taken must be replicated within each environment to ensure there is no significant deviation in the data used for making the ADS comparisons. SPJ Subobjectives 2-1 through 2-4 reflect the intent to perform multiple test iterations in each environment to determine the extent of variability in the data used to compare test results and provide the tester confidence in the repeatability of test results.

- **SPJ Obj 3: Correlate data between environments**
  - **Subobj 3-1: OAR-DSM duplicated threats**
  - **Subobj 3-2: OAR-HITL duplicated threats**

- **Subobj 3-3: OAR-ISTF duplicated threats**
- **Subobj 3-4: DSM-HITL duplicated threats**
- **Subobj 3-5: DSM-ISTF duplicated threats**
- **Subobj 3-5: HITL-ISTF duplicated threats**

Correlation will determine the validity of data collected in an ADS environment by applying both a qualitative and quantitative analysis to the test results that were measured in SPJ Objective 1 and analyzed in SPJ Objective 2. The qualitative analysis will assess consistency or apparent agreement. The quantitative analysis will serve to provide statistical confidence of the conclusions regarding the correlation between environments. If the results can be correlated, then it can be concluded that ADS is a valid test methodology.

- **SPJ Obj 4: Quantify effects of ADS induced errors**
  - **Subobj 4-1: Latency on the ADS test results**
  - **Subobj 4-2: Effects on human perception**
  - **Subobj 4-3: Others**

The use of ADS may induce errors in test results. This objective will address the effects on both the system performance and human perception/response. System performance errors will manifest themselves as parameters which cannot be correlated between the environments. These parameters will be analyzed in conjunction with network performance data to identify the impacts of ADS. One specific area to be examined is the impact of latency. Excessive latency or variability of latency has the potential to disrupt the timing and synchronization of the engagement exchanges between the SUT and threat systems. Another area where ADS has the potential to induce errors is in the perceptions and responses of humans in man-in-the-loop facilities. JADS will evaluate the ability of the human threat simulator operators to perceive differences in the operation of their systems in an ADS environment. Other areas will be identified as the test planning matures.

- **SPJ Obj 5: Measure ADS network performance**

ADS network performance is not peculiar to the EW SPJ test; however, this activity will provide information on the applicability of ADS to the configurations necessary for EW testing. In this objective, the results are oriented towards the technical networking issues. This information may become critical if it is necessary to analyze root causes of a lack of correlation between testing environments.

- **SPJ Obj 6: Measure ADS reliability**

ADS reliability is also not peculiar to the EW SPJ test. Like performance, it will provide data for configurations required of EW testing. This objective will provide information useful towards assessing the acceptability of ADS as a methodology. Unless there is complete confidence in the reliability of the ADS test configuration, the perceived costs of collecting valid data using ADS may outweigh the potential benefits. Since an ADS test involves several players, reliability problems impact testers at multiple facilities, each of which has devoted resources to the test. Any setback due to failure of the test configuration will result in additional costs and schedule slippage.

4.1.3 Phase II Self-Protection Jammer Test Objectives

The overall objective of Phase II of the SPJ test is to evaluate the utility of ADS to support evaluation of a self protection jammer in a full up mission level environment. Specific test objectives for Phase 2 testing are:

- **SPJ Obj 7: Measure SUT performance in an integrated mission level ADS environment.**

Self protection jammer performance is effected by a number of mission environmental factors. Examples include the performance of other avionics systems on the aircraft, the reactions of the pilot to the mission environment, the effect of stand-off jamming, the engagement scenario, etc. The effects of these factors on SPJ performance are significant and are difficult to measure in most test environments. This objective would evaluate how well this type of evaluation could be performed in a linked environment.

- **SPJ Obj 8: Assess the ability of an integrated mission level ADS environment to support the development of high level EW MOPs and MOEs.**

Ultimately, SPJ performance must be described in terms that describe the military utility of the system. Currently, this is accomplished in relatively low fidelity modeling and simulation. On the surface, an integrated mission level ADS test environment allows the performance of the SPJ to be evaluated in terms of mission success (number of bombs on target, number of aircraft lost, etc.) in a high fidelity test environment. This objective would evaluate how well the integrated mission environment supported the direct measurement of SPJ mission effectiveness.

- **SPJ Obj 9: Measure mission level ADS Network Performance**

The mission level ADS environment will be much more stressing than the ADS environment established in Phase 1. Network performance will be a critical issue. In this phase network performance will be oriented toward system level issues.

- **SPJ Obj 10: Measure ADS Network Reliability in an integrated environment**

A large number of players will be linked during phase 2 testing. This objective will assess the impact of network reliability on the conduct of large scale linked tests.

4.1.4 JADS Issues, Objectives, Measures, and EW Test Objectives

Table 4-1 shows the flow from JADS level issues to the specific objectives of each activity associated with the EW test. In doing so, it can be seen where the EW test anticipates being able to gather information to address JADS measures from an EW perspective. The EW test results will then be used to infer JT&E level conclusions. In addition to explicit issues, objectives, or requirements of the EW tests, there are several areas where observation and review of the test will provide insight into additional objectives. These have been listed in Table 4-1 as "JADS Assessment." This term is used to denote where we will be able to draw conclusions for that measure based on the results of a specific EW test. These conclusions will be based on indirect information as well as the ability to surmise how ADS could have contributed to the test process.

Table 4-1. Analysis Issues, Objectives, Measures, and EW Objectives

Issues	Objectives	Measures	Supporting EW Test Objectives	
Issue 1: What is the present utility of ADS, including DIS, for T&E?	Objective 1-1: Assess the validity of data from tests utilizing ADS, including DIS, during test execution.	M 1-1-0-1: Degree to which ADS provides valid SUT data.	SPJ	SPJ Obj 1, 2, 3, 7,8
			ADEWS	Assessment
		M 1-1-0-2: Percentage of ADS data which are valid (data supporting test measures which are timely, accurate, reliable, and otherwise faithfully represent real world systems data).	SPJ	SPJ Obj 1, 2, 3,7,8
			ADEWS	Assessment
		M 1-1-0-3: Degree to which test participants were able to distinguish between ADS (virtual or constructive) and live assets.	SPJ	SPJ Obj 1, 2, 3, 4,7,8
			ADEWS	Assessment
		M 1-1-0-4: Degree to which test actions were impacted due to the ability to distinguish between ADS and live assets.	SPJ	SPJ Obj 4
			ADEWS	Assessment
	Objective 1-2: Assess the benefits of using ADS, including DIS, in T&E. Subobjective 1-2-1: Assess ADS capability to support the early phases of the acquisition process.	M 1-2-1-1: Degree to which ADS can improve COEAs.	SPJ	Assessment
			ADEWS	Not Supported
		M 1-2-1-2: Degree to which ADS can improve requirements development.	SPJ	Assessment
			ADEWS	Not Supported
		M 1-2-1-3: Degree to which ADS can improve trade studies.	SPJ	Assessment
			ADEWS	Not Supported
		M 1-2-1-4: Degree to which ADS can improve Early Operational Assessments.	SPJ	Assessment
			ADEWS	Not Supported
		M 1-2-1-5: Percentage decrease/increase in cost during early acquisition phase due to ADS.	SPJ	Assessment
			ADEWS	Not Supported

Issues	Objectives	Measures	Supporting EW Test Objectives	
Issue 1: What is the present utility of ADS, including DIS, for T&E? (continued)	Objective 1-2: Assess the benefits of using ADS, including DIS, in T&E. (continued) Subobjective 1-2-2: Assess ADS capability to support T&E planning and test rehearsal.	M 1-2-2-1: Degree to which test concept/design is improved by ADS.	SPJ	Assessment
			ADEWS	Assessment
		M 1-2-2-2: Degree to which pre-test rehearsals of test exercise/ control procedures using ADS improved test preparations.	SPJ	SPJ Obj 1-2,1-3, 1-4 2-1,2-3,3-2,4,5,67,8
			ADEWS	Not Supported
		M 1-2-2-3: Degree to which pre-test rehearsals of data management procedures using ADS improved test preparations.	SPJ	SPJ Obj 1-2,1-3,1-4 2-2,2-3,3-2,4,5,6,7,8
			ADEWS	Not Supported
		M 1-2-2-4: Degree to which pre-test exercise of data reduction and analysis routines using ADS improved test preparations.	SPJ	SPJ Obj 1-2,1-3,1-4, 2-2,2-3,3-2,4,5,6,7,8
			ADEWS	Not Supported
		M 1-2-2-5: Degree to which ADS can be used for tactics development prior to test execution.	SPJ	SPJ Obj 1-2,1-3,1-4 2-2,2-3,3-2,4,5,6,7,8
			ADEWS	Assessment
		M 1-2-2-6: Percentage decrease/increase in test planning and rehearsal cost due to ADS.	SPJ	SPJ Obj 1-2,1-3, 1-4, 2-2,2-3,3-2,4,5,6,7,8
			ADEWS	Not Supported
	Subobjective 1-2-3: Assess ADS capability to support T&E execution.	M 1-2-3-1: Degree to which ADS can add assets to test execution.	SPJ	SPJ Obj 1-2,1-3, 1-4,7
			ADEWS	Assessment
		M 1-2-3-2: Degree to which added ADS assets added value to the test (realism) beyond that available without the appropriate numbers or types of targets, threats, etc.	SPJ	Assessment
			ADEWS	Assessment
		M 1-2-3-3: Degree to which ADS can increase test time, events, etc.	SPJ	Assessment
			ADEWS	Assessment

Issues	Objectives	Measures	Supporting EW Test Objectives	
Issue 1: What is the present utility of ADS, including DIS, for T&E? (continued)	Objective 1-2: Assess the benefits of using ADS, including DIS, in T&E. (continued) Subobjective 1-2-3: Assess ADS capability to support T&E execution. (continued)	M 1-2-3-4: Degree to which ADS can test hazardous or unsafe conditions safely.	SPJ	Assessment
			ADEWS	Assessment
		M 1-2-3-5: Degree to which ADS can be used to validate DT&E specification compliance (sooner or at less cost), e.g. using HWIL simulations.	SPJ	SPJ Obj 1,2,3,
			ADEWS	Assessment
		M 1-2-3-6: Percentage decrease/increase in test execution cost due to ADS.	SPJ	Assessment
			ADEWS	Not Supported
Issue 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E?	Objective 2-1: Assess the critical constraints and concerns in ADS performance for T&E. Subobjective 2-1-1: Assess player instrumentation and interface performance constraints and concerns.	M 2-1-1-1: Degree to which live, virtual, and constructive entities exist, can be instrumented, and can be readied for a test.	SPJ	Assessment
			ADEWS	Assessment
	Subobjective 2-1-2: Assess network and communications performance constraints and concerns	M 2-1-2-1: Degree to which network systems are available for ADS use.	SPJ	SPJ Obj 5,6 ,9,10
			ADEWS	Assessment
		M 2-1-2-2: Percentage of ADS trials canceled or otherwise not used due to network problems.	SPJ	SPJ Obj 5, 6,9,10
			ADEWS	Assessment
		M 2-1-2-3: Percentage of available bandwidth (average, peak) used by entity type.	SPJ	SPJ Obj 5,9
			ADEWS	Assessment
		M 2-1-2-4: Percentage of available bandwidth (average, peak) used by PDU type.	SPJ	SPJ Obj 5,9
			ADEWS	Assessment
		M 2-1-2-5: Percentage of time PDUs were received out of order by a network node.	SPJ	SPJ Obj 5,6,9,10
			ADEWS	Assessment

Issues	Objectives	Measures	Supporting EW Test Objectives	
Issue 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E? (continued)	Objective 2-1: Assess the critical constraints and concerns in ADS performance for T&E. (continued) Subobjective 2-1-2: Assess network and communications performance constraints and concerns. (continued)	M 2-1-2-6: Percentage of total PDUs required at a node that were delivered to that node.	SPJ	SPJ Obj 5, 6,9,10
			ADEWS	Assessment
		M 2-1-2-7: Average and peak data latency between ADS nodes.	SPJ	SPJ Obj 4
			ADEWS	Assessment
	Subobjective 2-1-3: Assess the impact of ADS reliability, availability and maintainability on T&E.	M 2-1-3-1: Percentage of trials delayed, rescheduled, and/or redone due to the ADS systems' (exclusive of network) unavailability.	SPJ	SPJ Obj 6,10
			ADEWS	Assessment
		M 2-1-3-2: Percentage of ADS trials delayed, rescheduled, and/or redone due to unavailability of planned networks (e.g. DSI).	SPJ	SPJ Obj 6,10
			ADEWS	Assessment
		M 2-1-3-3: Percentage of trials in which network connection was lost long enough to require trial cancellation.	SPJ	SPJ Obj 6,10
			ADEWS	Assessment
		M 2-1-3-4: Degree to which trial delays, reschedules, redo's compare to real world delays, schedules, redo's due to weather, maintenance, etc.	SPJ	SPJ Obj 5, 6,9,10
			ADEWS	Assessment
		M 2-1-3-5: Mean operating time between ADS system failures (severe enough to require trial cancellation).	SPJ	SPJ Obj 6,10
			ADEWS	Assessment
		M 2-1-3-6: Average down time due to ADS network failures.	SPJ	SPJ Obj 6,10
			ADEWS	Assessment

Issues	Objectives	Measures	Supporting EW Test Objectives	
Issue 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E? (continued)	Objective 2-2: Assess the critical constraints and concerns in ADS support systems for T&E. (continued) Subobjective 2-2-1: Assess the critical constraints and concerns regarding ADS data management and analysis systems.	M 2-2-1-1: Degree to which ADS nodes provide for collection, data entry, and quality checking of pre and post trial briefing data.	SPJ	Assessment
			ADEWS	Assessment
		M 2-2-1-2: Adequacy of relevant test data storage at ADS nodes.	SPJ	Assessment
			ADEWS	Assessment
		M 2-2-1-3: Adequacy of data translation systems at ADS nodes.	SPJ	Assessment
			ADEWS	Assessment
		M 2-2-1-4: Ease with which data can be retrieved, post-trial, from a given node.	SPJ	Assessment
			ADEWS	Assessment
	Subobjective 2-2-2: Assess the critical constraints and concerns regarding configuration management of ADS test assets.	M 2-2-2-1: Degree to which test managers can control the configurations of ADS participants, the ADS environment data, and ADS networks.	SPJ	Assessment
			ADEWS	Assessment
		M 2-2-2-2: Degree to which entity data exchange standards exist and are adequate.	SPJ	Assessment
			ADEWS	Assessment
	Objective 2-3: Develop and assess methodologies associated with ADS for T&E. Subobjective 2-3-1: Develop and assess methodologies associated with test planning for tests using ADS.	No measures have been developed for this Subobjective.	SPJ	Assessment
			ADEWS	Assessment

Issues	Objectives	Measures	Supporting EW Test Objectives	
Issue 2: What are the critical constraints, concerns, and methodologies when using ADS for T&E? (continued)	Objective 2-3: Develop and assess methodologies associated with ADS for T&E. (continued) Subobjective 2-3-2: Develop and assess methodologies associated with test execution and control for tests using ADS.	M 2-3-2-1: Degree to which specialized rules of engagement are required for live, virtual, and constructive entity mixes.	SPJ	Assessment
			ADEWS	Assessment
		M 2-3-2-2: Ease with which rule/ constraint violations may be accomplished without detection.	SPJ	Assessment
			ADEWS	Assessment
		M 2-3-2-3: Degree to which protocols, processes and procedures are needed to enable effective, centralized test control.	SPJ	Assessment
			ADEWS	Assessment
		M 2-3-2-4: Degree to which real-time analysis systems support test safety and other test control requirements.	SPJ	Assessment
			ADEWS	Assessment
	Subobjective 2-3-3: Develop and assess methodologies associated with data management and analysis for tests using ADS.	No measures have been developed for this Subobjective.	SPJ	Assessment
			ADEWS	Assessment
	Subobjective 2-3-4: Develop and assess methodologies associated with verification, validation, and accreditation (VV&A) for tests using ADS.	No measures have been developed for this Subobjective.	SPJ	Assessment
			ADEWS	Assessment
Issue 3: What are the requirements that must be introduced into ADS systems if they are to support a more complete T&E capability in the future?	Objective 3-1: Identify requirements for ADS systems that would provide a more complete T&E capability in the future.	No measures have been developed for this Objective.	SPJ	Assessment
			ADEWS	Assessment

4.2 DATA COLLECTION PROCESS

Effective data collection is essential to conducting a proper analysis of the overall EW test. This process starts with identifying data requirements and then recognizing what data is available from the tests and finally how to capture it. Data collection will be accomplished using both qualitative and quantitative means. Where appropriate, user questionnaires and interviews will be administered to evaluate the operator's perception of the ADS test scenarios. Subject matter experts will also be called upon to make judgments concerning the benefits and advantages/disadvantages of the EW activities. For quantitative data requirements, appropriate software and instrumentation will be used to capture relevant information and statistics.

4.2.1 ADEWS Data

Data collected from the Army's ADEWS test activities will be used to address ADS utility for EW T&E and to broaden JADS EW test results. The amount and type of quantitative data gathered will depend on the Army test, instrumentation, and data collection requirements. JADS will also collect qualitative data to assess ADS performance based on operator perceptions. Detailed planning for JADS activities with ADEWS will be accomplished when the Army test plan is available.

4.2.2 SPJ Test Phase I Data

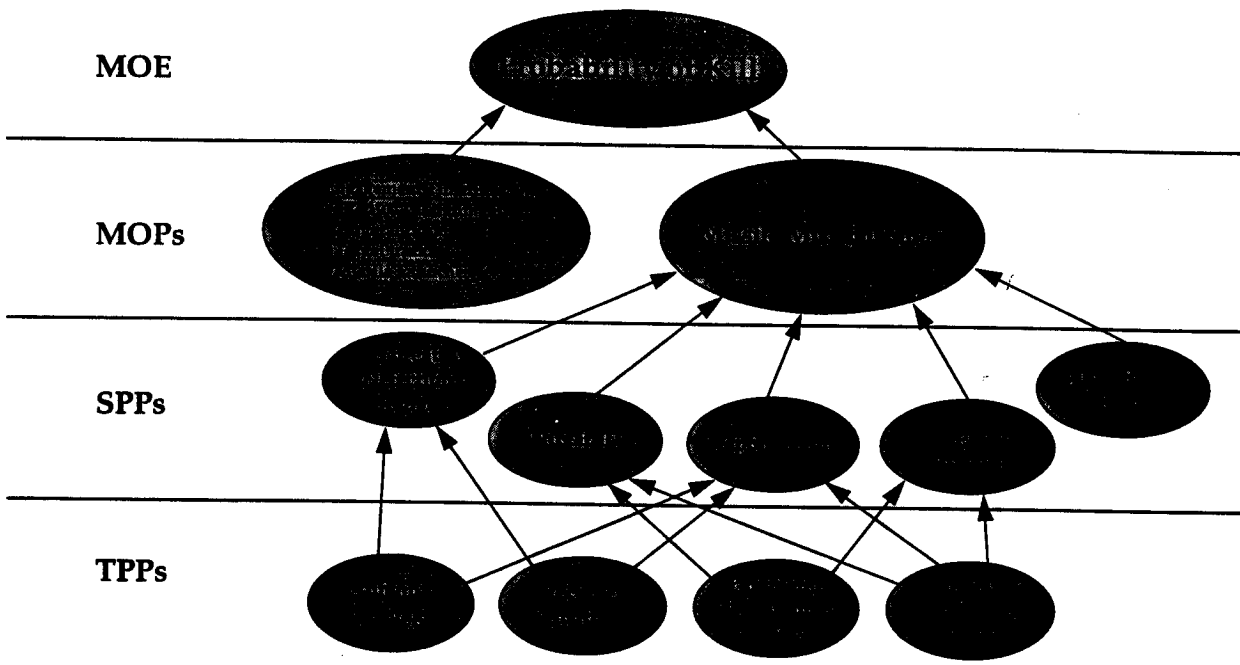
Data collection for Phase I of the SPJ test will be focused on elements that allow comparisons between the baseline SUT performance on the OAR and the corresponding performance in the DSM, HITL, and ISTF environments. The data elements collected for each will consist of similar, if not identical, parameters on SUT performance. This information will be used to directly fulfill SPJ Objective 1 and through analysis, to indirectly address SPJ Objectives 2 and 3. Table 4-2 shows the data to be collected and its anticipated use.

DATA	UTILIZATION
Recorded A/C TSPI	Flight profile simulation (x,y,z,t)
A/C attitude vs. time	Flight profile simulation (roll, pitch, yaw)
Target assignments vs. time	Threat environment characterization Programming environment generators Correlation of target assignments in ADS environment
Threat modes of operation vs. time	Threat environment characterization Programming environment generators Correlation of strategic and tactical C^3 target detection and acquisition
Unintended RF emissions vs. time	Correlation of terminal threat MOPs Threat environment characterization
RWR emitter track files and display files	Programming environment generators Threat environment characterization (backup)
ECM techniques vs. time	SUT behavior characterization Correlation with DSM and ISTF SUT responses in ADS test environment
Tracked target position vs. time	Tracking error vs. time Correlation with DSM and ISTF SUT responses in ADS test environment
JSR vs. time for each terminal threat	Programming signal injection resources Correlation with DSM and ISTF SUT responses in ADS test environment
Test A/C RCS data vs. frequency (monostatic & bi-static)	Programming signal injection resources
Radar scope displays vs. time	Visual comparisons with signal injection scope displays
Missile launch times, TSPI, miss distance	V&V missile flyout models Miss distance statistics

Table 4-2 SPJ Data Collection and Utilization

4.2.3 SPJ Test Measurement Hierarchy

The technical and system performance parameters of a SPJ are shown below. These parameters support the determination of the missile miss distance measure of performance. The calculation of missile miss distance combined with engagement timelines for a specific terminal threat support the determination of a typical SPJ measure of effectiveness, Probability of Kill (P_k).



4.2.4 SPJ Test Phase II Data and Instrumentation

Table 4-3 presents the instrumentation that will be used to collect the required data. GTRI has developed automated data reduction software to use to interpret and graphically display data collected through this instrumentation.

DATA REQUIREMENTS	INSTRUMENTATION
Recorded A/C TSPI	Reference radars GPS
A/C attitude vs. time	Inertial navigation system
Target assignments vs. time	C^3 message monitor Manual log
Threat modes vs. time	Threat system "switchology" vs. time Real-time environment monitor (e.g., EMVI) Site event logs
Unintended RF emissions vs. time	Real-time spectrum surveillance system
RWR emitter track files and display files	Firefly digital flight recorder
ECM techniques vs. time	SUT output monitors (e.g., JMVI)
Tracked target position vs. time	Threat system pedestal/antenna position monitor
JSR vs. time	Jamming analysis and measurement system (e.g., JAMS)
Test A/C RCS data vs. frequency	Calibrated received signal power monitor (e.g., JAMS)
Radar scope displays vs. time	Video camera / recorder
Missile launch times, TSPI, & miss distance	Standard missile fly-out models

Table 4-3 Instrumentation

Data collected to support SPJ Objectives 4 and 5 will be similar to that used by the JADS System Integration Test and End-to-End Test. These measures of network performance and reliability will be refined as those tests progress.

4.3 Data Analysis Process

As in the initial collection, the challenge of data analysis is to integrate results of all EW activities into a cohesive analysis process which addresses the critical ADS issues. Analysis will be quantitative to the greatest extent possible and supported by qualitative assessments. Standardized data reduction techniques will aid in this effort.

4.3.1 ADEWS

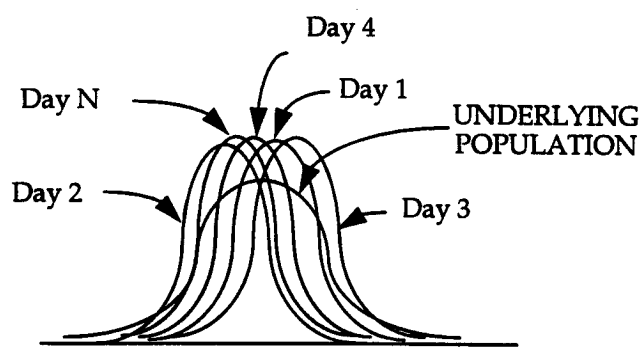
The analysis process will be developed after the ADEWS test and data requirements are defined by the Army Electronic Proving Ground.

4.3.2 SPJ Test Phase I Analysis

Data analysis for the SPJ test will center around correlation of results between environments used for the test. By statistically proving that there is not a significant difference between data collected in the four environments (i.e., OAR, DSM, HITL, and ISTF), it would lead to the conclusion that the ADS network does in fact provide valid data and has some utility as a testing methodology. The actual data analysis begins with SPJ Objective 2, which is to establish the variability of OAR and ADS test results. The two methods to accomplish this objective are: 1) Establish ranges of statistics for event data, and 2) Establish ranges of correlation coefficients for series data. In order to accomplish this, multiple runs must be made in each test environment with all data elements collected in each run.

4.3.2.1 Statistical Range: Event and Series Data Analysis

Examples of event data are miss distance and detection range. For each data element, the values from each run will be used together to establish descriptive statistics and determine the underlying population, based on the distribution of data from the individual runs. This concept is illustrated by figure 4-1 below. The resulting descriptive statistics can then be compared across environments to determine the overall variability.



RANGE OF STATISTICS			
DATA	MEAN	STD DEV	Dmax
DAY 1	22	3.1	0.35
DAY 2	30	4.0	0.30
DAY 3	25	3.5	0.25
DAY 4	27	3.9	0.38
DAY N	32	4.5	0.40

Dmax RANGE = <.40

Figure 4-1 Event Data Variability

Examples of series data are tracking error or received signal amplitude. In these measures, each data set from individual runs are plotted on a grid of two parameters to obtain a trend among the data. The sets are then averaged to determine a composite trend for each measure. By comparing the original trends to the composite, a correlation coefficient can be determined for each data set. This concept is illustrated in figure 4-2 below.

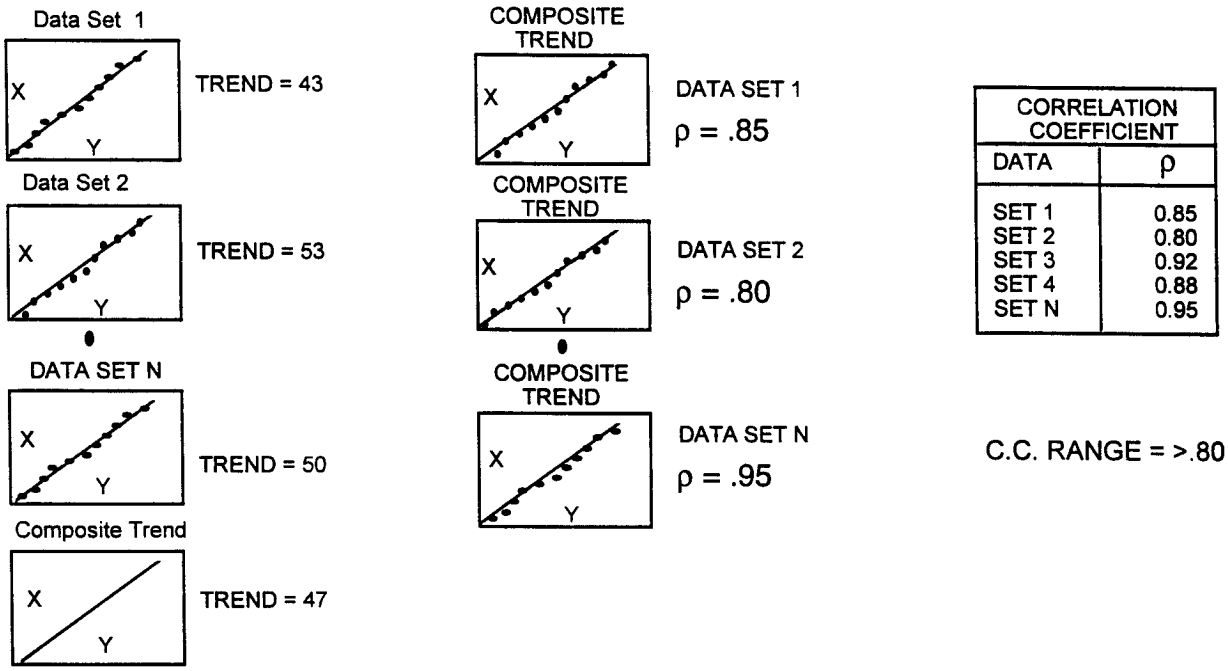


Figure 4-2 Series Data Variability

4.3.2.2 Correlation Range: Qualitative and Quantitative Analysis

SPJ Objective 3 is to correlate data between environments, which uses both qualitative and quantitative approaches. The concept behind the qualitative correlation is to make sure that the data is sensible prior to performing detailed quantitative analysis. The flowchart in figure 4-3 outlines the steps for making this analysis. The initial criteria is to evaluate performance in comparison to exit criteria. If it is consistent, then the next step is to proceed to the quantitative analysis. If not, then the discrepancy must be reconciled before proceeding.

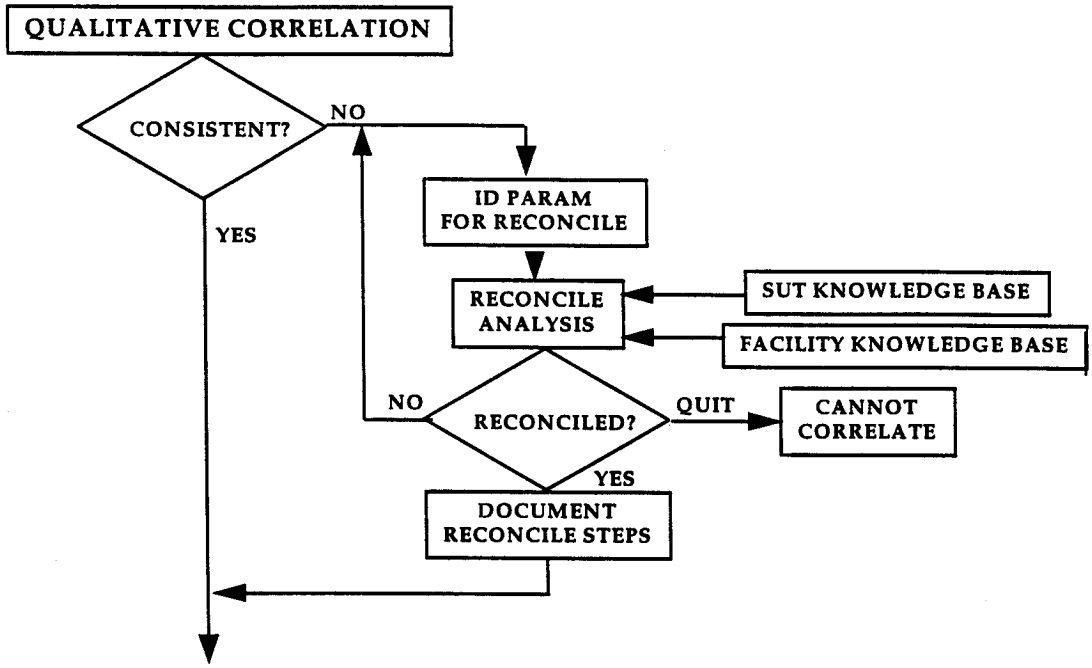


Figure 4-3 Qualitative Correlation Analysis

Quantitative Correlation Analysis can be performed in different ways (i.e., performance, population, and classical), each of which provides a different degree of intuitive appeal and insight into the relationship between the data being examined.

Performance Correlation is defined as "The percent of RTCs in which system performance pass/fail decisions match between predicted results and test results or test results from two or more different facilities." It has the most intuitive appeal for decision makers because of its easy to identify pass/fail nature. In this analysis, the distribution functions of a performance measure from two different environments are both plotted on an axis with values of that measure. There is also a threshold value for comparison of the curves. If the majority of the curve is above the threshold, it may be declared a 'pass'. If both curves meet the pass criteria, then one may be deemed to be an accurate approximation of the other. By calculating the percentage of matches from multiple runs, a correlation coefficient can be determined.

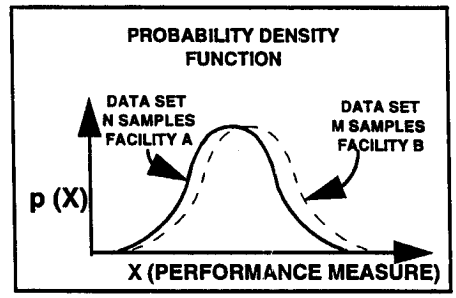


Figure 4-4 Performance Correlation

Population Correlation is defined as "The probability that two or more samples of system performance data measured in a given RTC were drawn from the same underlying population." While this method has less overall intuitive appeal, it can assist in determining which of the supporting performance measures caused a lack of correlation in the first method. Population correlation is illustrated in figure 4-5. As shown in the figure, probability density functions of two data sets are plotted and the maximum difference between them is calculated. This difference is the Smirnov statistic. Using this statistic, the next step of the analysis is to conduct hypothesis testing at a desired confidence interval. Comparing Dmax to the resulting critical value will determine whether or not the two come from a common distribution.

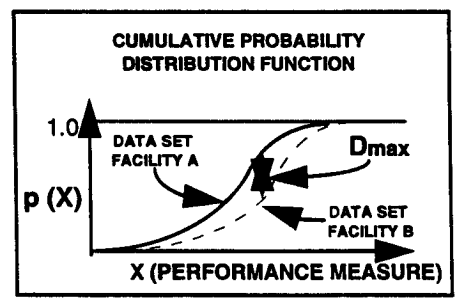


Figure 4-5 Population Correlation

Classical Correlation is defined as "The dispersion relative to a functional relationship between two or more variables." It allows analysis into the possibility of cause and effect relationships. While possessing the least intuitive appeal, this method can better point to the reason for mismatches in data. This type of correlation is performed by developing a scatter diagram of the data and labeling it as having low correlation, high correlation, or nonlinear correlation.

4.3.3 SPJ Test Phase II Analysis

Data analysis for Phase II testing will focus on a COEA level approach for addressing overall system effectiveness with data generated at OT&E fidelity levels by using ADS to link high fidelity threats. Data analysis will be similar to the phase I methods for deriving top level SPJ MOEs including probability of survival and mission effectiveness. A detailed analysis methodology had not been developed for Phase II prior to learning that the JADS EW test was not chartered. Further planning on this effort was suspended.